

REMARKS

Claims 4-7, and 10-15 remain pending in the application with the present amendments. Claim 17 is canceled herein. In the Office Action, the Examiner rejected claims 4-7, 10-15 and 17 under 35 U.S.C. §103(a) as being obvious over U.S. Patent No. 6,426,254 B2 to Kudelka et al. ("*Kudelka*") in view of U.S. Patent No. 6,660,582 B2 to Birner et al. ("*Birner*"). For the reasons set forth below, Applicants respectfully submit that the presently amended claims are fully distinguished over *Kudelka* and *Birner*. Reconsideration and allowance of the pending claims is requested.

As now recited in amended claim 10 herein, from which all other pending claims depend, a method is provided of forming a trench capacitor on a semiconductor substrate. The method includes forming a pad stack including a first material on a semiconductor substrate and then forming a hard mask including a second material over the pad stack, wherein the first material is etch distinguishable from the second material. The hard mask and the pad stack are then patterned to form aligned openings in the hard mask and the pad stack extending from a top surface of the hard mask to a top surface of the semiconductor substrate. The semiconductor substrate is then etched through the aligned openings to form a trench. The sidewalls of the trench are then horizontally widened by a first etch process to form a widened trench having widened sidewalls extending from the top surface of the semiconductor substrate. Then, the sidewalls of the opening in the pad stack are widened by a second etch process which has etch selectivity to the second material to form a widened opening in the pad stack relative to the opening in the hard mask. In this way, the hard mask overhangs the widened sidewalls of the widened opening in the pad stack and

overhangs the widened sidewalls of the widened trench. Further steps are performed to form a capacitor including forming a sacrificial collar on the widened sidewalls of the widened trench; vertically deepening the trench to create a lower portion extending below the sacrificial collar; and forming a capacitor in the lower portion.

Thus, as amended herein, claim 10 now requires that the hard mask and the pad stack include a first material and a second material, respectively, which are etch distinguishable from each other. The hard mask and the pad stack are first patterned to form aligned openings extending from a top surface of the hard mask to a top surface of the semiconductor substrate. After the semiconductor substrate is vertically etched to form a trench, the sidewalls of the trench are horizontally widened by a first etch process to form a widened trench having widened sidewalls which extend from the top surface of said semiconductor substrate. The sidewalls of the opening in the pad stack are then widened by a second etch process which has etch selectivity to the second material so as to form a widened opening in the pad stack relative to the opening in the hard mask.

By contrast, the invention as recited in claim 10 is neither taught nor suggested by *Kudelka* or by the combination of *Kudelka* with *Birner*. *Kudelka* merely describes a method of widening a trench, but not the performance of other steps in such way as recited in claim 10. Passages of *Kudelka* (col. 4, Ins. 24-47) cited by the Examiner in rejecting the claims merely describe a method of widening the trench and the overlying hard mask through a wet etch process. *Kudelka* neither teaches nor suggests a process as recited in claim 10 in which the trench has *widened sidewalls extending from the top surface of the substrate*, and in which, *after the trench is widened*, an opening in a pad

stack is widened by a second etch process having etch selectivity to the second material. By such second etch process, the opening in the pad stack is widened relative to the opening in the overlying hard mask such that the hard mask overhangs the widened sidewalls of the widened opening in the pad stack.

Moreover, other features recited in the claims are neither taught nor suggested by *Kudelka*. *Kudelka* neither teaches nor suggests the feature recited in claim 5 of widening the trench using a chemistry including an HNO₃/HF mixture. (Cf. *Kudelka* col. 5, ln. 61 through col. 6, ln. 12 which teaches a different chemistry). *Kudelka* also neither teaches nor suggests that the hard mask is formed of a TEOS deposited oxide layer or a BSG deposited oxide layer. The passage of *Kudelka* (col. 4, ln. 53 to col. 5, ln. 3) cited by the Examiner merely describes forming a TEOS *collar* in the trench, not the formation of a hard mask.

Moreover, *Birner* neither teaches nor suggests the features of the invention which *Kudelka* lacks with respect to the presently claimed invention. The passage of *Birner* (col. 8, lns. 10-32) cited by the Examiner does not describe widening sidewalls of an opening in a pad stack relative to a hard mask. In fact, *Birner* does not teach etching through an opening in both a hard mask and a pad stack, certainly not one in which a pad stack includes a first material and a hard mask includes a second material which is etch distinguishable from the first material. *Birner* merely teaches *one* etching mask layer 100 (col. 8, lns. 5-7) disposed over the semiconductor substrate. Moreover, neither the process described in *Birner* nor that in *Kudelka* results in a structure in which a hard mask overhangs the widened sidewalls of an opening in a pad stack. This is evident because *Birner* teaches only *one* etching mask layer 100 and *Kudelka* does not

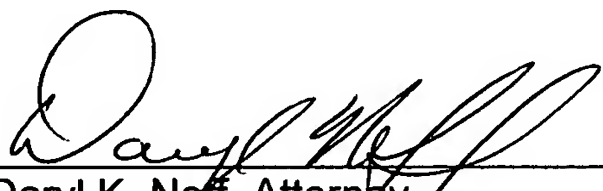
teach an etch process having etch selectivity to a material of a hardmask in relation to that of a pad stack.

Accordingly, in view of the amendments and remarks herein, it is believed that all claims of the application are now in condition for allowance. However, if for any reason the Examiner does not believe that such action can be taken at this time, the Examiner is requested to telephone the Applicants' attorney at the number indicated below to discuss any issues that may remain.

It is believed that no fee is due in connection with the filing of this Amendment. However, if any fee is due, authorization is granted to debit the Deposit Account No. 09-0458 of the Assignee. If there is an overpayment, please credit the same account.

Respectfully submitted,
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